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Australasian Plant Conservation

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Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research and diary dates are welcome. General articles on any plant conservation issue are most welcome.

The deadline for the **September – November 2018 issue is 20 July 2018**. The special theme for the issue is **Threatened plant conservation from the ecological consultant's perspective.** If you are intending to submit an article or wish to discuss possibilities, please email the editor, Heidi Zimmer: **editor@anpc.asn.au**

Authors are encouraged to submit images with articles or information. Please submit images in electronic format, resolution needs to be at least 300 dpi, at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors and an article template are at: **http://www.anpc.asn.au/apc**.

Using the article template, please send articles, no more than 1200 words, as an MS Word file by email to: **editor@anpc.asn.au**.

This issue

Regular features

The production of this edition of *Australasian Plant Conservation* was supported by the **NSW Environmental Trust** through its Lead Environmental Community Groups program.

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From the editor

HEIDI ZIMMER

Welcome to the second issue of *Australasian Plant Conservation* focusing on threatened plant translocation, as the release of the Third Edition of ANPC's 'Guidelines for the Translocation of Threatened Plants' draws near.

We begin this issue in Western Australia where Dave Coates *et al.* describe the complexities of translocating *Banksia brownii,* a species highly susceptible to *Phytophthora*. Coates *et al.* use genetic analysis to confirm differentiation of three populations of *B. brownii*, and hence they aim to establish three new populations using translocation. Next we move to South Australia, where Manfred Jusatis tells the story of *Haloragis eyreana* translocation. His findings highlight the importance of microsites as the best recruitment of *H. eryana* in artificially established trenches, likely because of soil moisture and disturbance.

A case study from New South Wales is next, where Keith McDougall *et al.* provide an account of the challenge of translocation of *Pomaderris delicata* – best survival was of plantings within an extant wild site, while the new site "failed rapidly". McDougall *et al.* intend to try again, at a site that already has other species of *Pomaderris*. We then move back to South Australia and a second case study on translocation of *Prostanthera eurybioides* (see also Jusatis *et al.* in *APC* 26-4). Kylie Moritz *et al.* highlight the influence of watering, weeding and fencing on plant survival, and discuss the impact of variation in seed production (in wild populations) on translocation planning.

We then have two case studies that describe the translocation of multiple species. First Andrew Benwell describes salvage translocations of a subtropical species resulting from a highway upgrade in New South Wales. For one species, *Marsdenia longiloba*, they trial a number of approaches to increase translocation success, finding that seedlings were more vigorous than vegetatively propagated plants, and fertiliser addition negatively affected growth and survival. Then we shift our focus to the value of volunteers in translocation, as Noushka Reiter and Richard Thompson show the important role of the Australasian Native Orchid Society Victoria Group in translocation projects on *Caladenia colorata*, *C. fulva* and *Thelymitra mackibbiniii.*

In our regular features we have news from the Australian Seed Bank Partnership, highlighting the work of the Australian PlantBank in translocating *Hibbertia puberla* subsp. *glabrescens*. The workshop report describes the *Banksia marginata* workshop in Harcourt, Victoria. Our member profile puts the spotlight on Manfred Jusatis, author of the *Haloragis eyreana* case study above – and so much more! We also have a pertinent book review – the new book by Sarah Legge *et al.* on "Monitoring Threatened Species and Ecological Communities". We finish with our plant cuttings – news clippings about plants – from around Australia.

Threatened plant translocation case study:

Banksia brownii (Feather Leaved Banksia), Proteaceae

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The Species

- Long-lived non-lignotuberous shrub or small tree.
- Endemic to Western Australia.
- 18 extant (surviving; in existence) natural populations, 10 with less than 100 plants, which occur over a 90 km range around Albany (to the north and east).
- Three biogeographically and genetically distinct population groups have been identified and are considered to be separate conservation units for management and recovery.

Threatening Processes

- *Phytophthora* dieback.
- Inappropriate fire regimes (i.e., too frequent fire and lack of fire).

Deciding to translocate

Banksia brownii is highly susceptible to the introduced soil-borne pathogen *Phytophthora cinnamomi,* which is considered to be the greatest threat to this species' ongoing persistence (Shearer *et al.* 2013). Of 30 known populations, 12 are now presumed extinct due to *Phytophthora* dieback, 10 have less than 100 plants; of these, eight have less than 10 mature plants remaining with the decline in numbers largely due to *Phytophthora* dieback. Genetic diversity studies based on material from extinct (*ex situ* seed collections) and extant populations indicate that some 38% of total genetic diversity, based on contributions of within population variation and differentiation, has been lost from *B. brownii* due to *Phytophthora* dieback (Coates *et al.* 2015).

Population genetic studies (using microsatellite genotyping) have demonstrated significant levels of differentiation among populations of *B. brownii* corresponding to the three geographically and historically isolated disjunct population groups; Stirling Range National Park (SRNP), Milbrook-Waychinicup and Vancouver Peninsula. These isolated population groups also display ecological differences, and they occupy contrasting habitats in terms of substrate, associated vegetation and climate. The three population groups are therefore considered to be discrete conservation units important for the management and recovery of *B. brownii* (Coates *et al.* 2015).

Banksia brownii has a long juvenile period, requiring a fire-free period of at least 15 years to reach maturity and accumulate an adequate seed bank, making it vulnerable to short fire intervals. Two fires in close succession, in 1991 and 2000, in the eastern Stirling Range had a significant impact with no or minimal regeneration of several populations (Gilfillan and Barrett 2008; Barrett and Yates 2015).

The species was declared as Rare Flora under the Western Australian *Wildlife Conservation Act* in November 1980 and is currently ranked as Critically Endangered. It is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The establishment of three translocated populations in new secure and disease-free locations was considered to be one of the most effective actions to initiate successful recovery of the species

Aim of the translocation

The aim of the translocation was to successfully establish three viable populations covering the three genetically and biogeographically distinct conservation units recognised in *B. brownii* (Figure 1). For each population the objective was to establish at least 200 mature adult plants in secure sites where threats, in particular *Phytophthora* dieback, were absent. An initial assessment of viability would be based on the production of viable seed and recruitment over subsequent generations.

Translocation working group and key stakeholders

- Department of Biodiversity, Conservation and Attractions (DBCA), Western Australia – to oversee development and implementation of translocation and ongoing monitoring and maintenance of translocation sites.

- Department of Biodiversity, Conservation and Attractions, Western Australia (Botanic Gardens and Parks Authority) – propagation of seedlings.
- Albany District Threatened Flora Recovery Team – to oversee implementation of Interim Recovery Plan for the species, including the translocations.

Biology and Ecology

- Primarily bird- and mammal-pollinated but insect pollination is also likely.
- Seeds are usually retained in the infructescences and remain viable for at least 30 years. They are released after fire.
- Recruitment is primarily confined to post-fire period.
- Population genetic studies have demonstrated significant genetic structure within *B. brownii* corresponding to the three geographically disjunct population groups. Higher levels of genetic diversity in the Stirling Range populations indicate larger and more stable population sizes over longer timeframes.
- The historically isolated population groups display ecological differences occupying contrasting habitats in terms of substrate, associated vegetation and climate.
- Climate is Mediterranean with hot dry summers and cool wet winters.

Site selection

Given the recognition of three genetically and biogeographically distinct conservation units within *B. brownii* (Figure 1), three separate translocations representing each conservation unit were considered optimal, to maximise the conservation of genetic diversity within the species. The three translocated populations would therefore represent the Stirling Range populations (Site 1), the Milbrook- Waychnincup populations (Site 2) and the Vancouver Peninsula population (Site 3).

A desktop GIS-based search was made of conservation reserves in the vicinity of the known *B. brownii* populations in each of the three regions to locate suitable sites. Search criteria included similar soil and vegetation to the natural populations, secure tenure, absence of threats and proximity to the known populations. Infestation with *Phytophthora* dieback was the most significant challenge as many otherwise suitable sites were infested. An additional factor in site selection was the risk of a major disturbance event (such as fire) and whether measures could be put in place to ensure the risk of an event affecting the translocated populations was low.

As it was not possible to locate a translocation site within areas of suitable habitat in the SRNP which was not affected by *Phytophthora* dieback, Site 1 was located north of the Porongurup Range in revegetated woodland on private property within 26 km of *B. brownii* populations in the SRNP. Translocations of several other Critically Endangered species susceptible to *P. cinnamomi* and endemic to the SRNP are also located on this site

Site 2 was located within remnant vegetation similar to the species' natural habitat on a *Eucalyptus globulus* (bluegum) plantation managed by the then Integrated Tree Cropping Pty Ltd (ITC), now Australian Bluegum Plantations (ABP). Significant areas of native vegetation within the plantation remain undisturbed and in good condition. The selected site was located within remnant vegetation on a high-point of a lateritic ridge and is *Phytophthora*-free.

Site 3 was located on Snake Hill in Torndirrup National Park, within 4.3 km of the natural population of the Vancouver Peninsular population of *B. brownii* in *Phytophthora*-free habitat similar to that of the natural population.

Translocation proposal

Two Translocation Proposals were developed; one for the Stirling Range and Milbrook – Waychinincup populations (Barrett and Jackson 2006) and one for the Vancouver Peninsula populations (Barrett *et al.* 2008). These were developed using a template provided by the then Department of Environment and Conservation (DEC), now DBCA, to guide and provide justification for the translocation. The Proposals were submitted to DEC where they were assessed by two independent reviewers as to whether they met DEC's policy on plant translocations, before being given approval for the translocation process to commence.

Pre-translocation preparation, design, implementation and ongoing maintenance

Each translocation was established with seedlings grown from seed collected from natural populations which has been stored in the DBCA Threatened Flora Seed Centre covering the three genetically and biogeographically distinct regions. Two translocation sites (Sites 1 and 2) were established with a proportion of seed collected from now extinct populations.

At each site, seedlings were established during winter and planted roughly in rows, amongst the existing vegetation, with progeny from the same maternal plant kept separate. Each plant was permanently tagged for monitoring purposes and caged to prevent grazing by rabbits and kangaroos. An automatic solar-powered irrigation system was established in spring to water plants during the first and second summer. As a precautionary measure to protect the translocation sites from disease, all equipment used during planting and monitoring was maintained under strict disease hygiene, with access restricted to dry soil conditions. Vehicles and footwear were cleaned of soil before entering the natural populations and translocation sites.

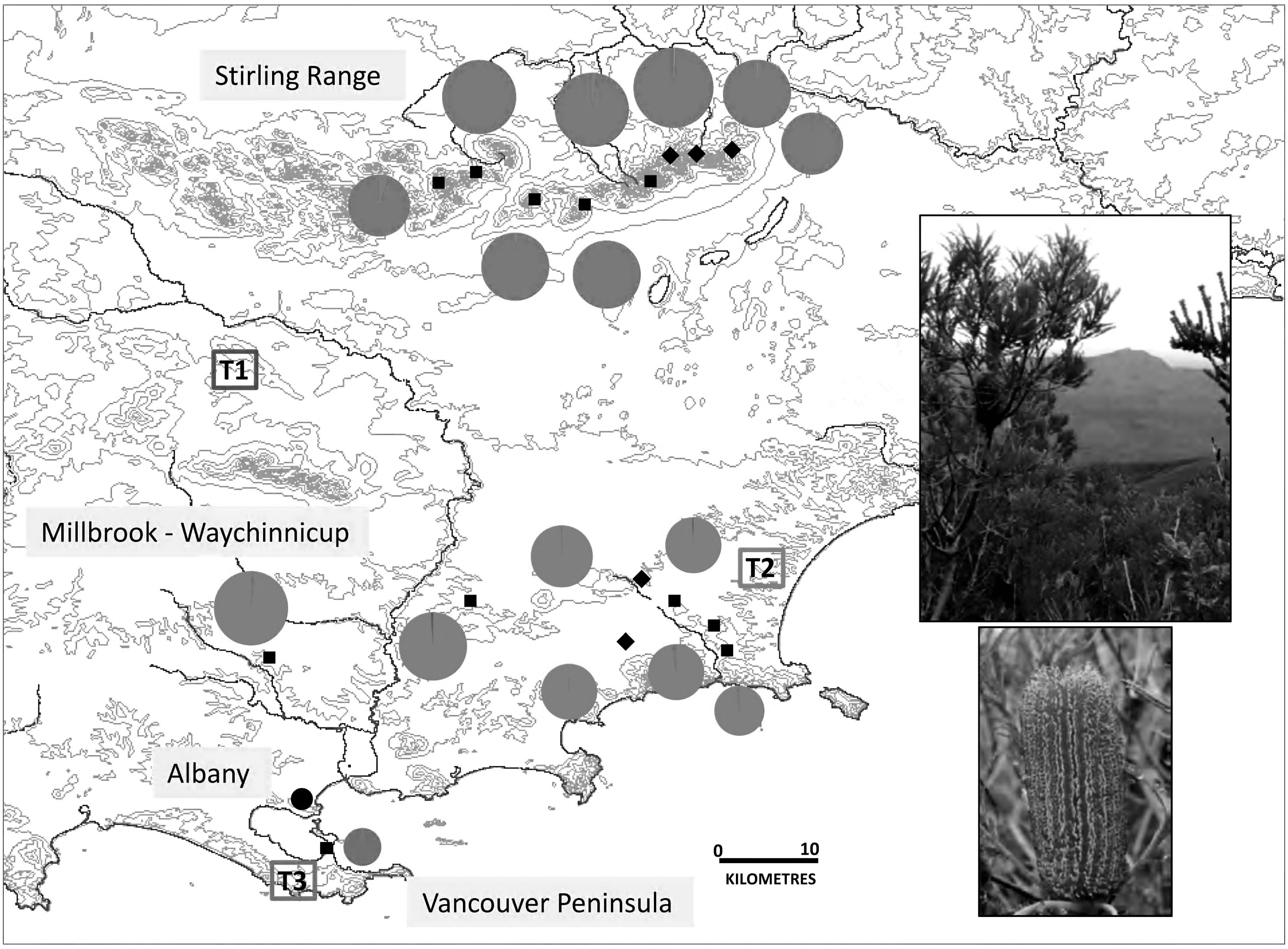

Figure 1. Mean q-matrix membership proportions of *Banksia brownii* populations (pie charts) when K=3 from a STRUCTURE analysis (see Coates *et al.* 2015). The size of pie charts is relative to the level of genetic diversity. Extant populations ■. Germinated seed from extinct populations ♦ was initially used to establish two separate translocated populations (T1 and T2) in disease free areas. Translocated population T3 was established with seed from the single Vancouver Peninsula population.

At Sites 1 and Site 2, the land managers, Mr Luscombe and ABP, currently implement *Phytophthora* hygiene procedures at the sites, maintain firebreaks and will aid in fire suppression activities if necessary. A management agreement has previously been entered into between Mr Luscombe and ABP with the Department, for translocations, which will ensure access for Departmental staff and the protection of translocated plants.

Site 3 within the Torndirrup National Park is managed by DBCA with strict *Phytophthora* hygiene procedures followed in the park. The site is situated within a fuel reduction zone that provides a protective buffer between Torndirrup National Park and the adjacent residential area.

Monitoring and evaluation

Detailed monitoring of the translocated population is undertaken every 12 months. More frequent informal monitoring is undertaken where possible. Detailed monitoring included counting the number of surviving plants and their height, width of the crown in two directions, reproductive state, number of inflorescences and fruits, whether second generation plants are present and the general health of the plants. To provide essential baseline data for assessing the performance of the translocated population, basic monitoring of selected original populations is also carried out every 12 – 24 months.

After 10 years, survival at site 1 is 20%, site 2 is 49% and site 3 is 50%. After an initial three years of good health and survival at site 1, extended dry periods resulted in a decline of plant numbers, indicating the site has become unsuitable for this species.

Subsequent actions

Banksia brownii is the sole host to the Critically Endangered herbivorous plant-louse *Trioza barrettae.* A coordinated approach to prevent co-extinction has recently involved the successful translocation of the plant louse from the Vancouver *B. brownii* population to the new translocated population (T3, Figure 1) (Moir *et al.* 2016).

Seed collection has been made from Site 2 for long term storage in the Departments' Threatened Flora Seed Store.

Outcomes

The aim to successfully establish three populations covering the three genetically and biogeographically distinct conservation units recognised in *B. brownii* has been met although long term viability has yet to be established. While all three translocated populations have flowered and produced seed from multiple plants, recruitment has only been observed at Site 2. The decline in plant numbers at site 1 has aided in more accurately defining the site characteristics required for this species, with further translocations at wetter sites required to conserve the Stirling Range population group. At Site 3, initial plantings in open granite habitat had poor survival, subsequent plantings targeted deeper, more vegetated soils.

What we learned

- It is possible to establish new populations of this species.
- Using an experimental framework when establishing translocations can provide critical information for long-term translocation success.
- This species may require higher moisture conditions than other Proteaceae from the region.
- Fencing and summer watering improves survival of planted seedlings.
- At site 3, optimal micro-habitat within the site was identified to ensure success.

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Threatened plant translocation case study:

Haloragis eyreana (Prickly Raspwort), Haloragaceae

MANFRED JUSAITIS*

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The Species

- Small, perennial herb with a deep stoloniferous rootstock.
- Endemic to southern Eyre Peninsula, South Australia.

Threatening Processes

- Habitat loss and fragmentation through agricultural development.
- Weed competition.
- Roadside management activities.
- Altered hydrological regimes.

Deciding to translocate

Extensive surveys between 1997-1999 counted approximately 16,000 individuals with an area of occupancy of 0.8 km^2 and an extent of occurrence of 711 km^2 (Jusaitis and Freebairn 2011). Since 1999, plant numbers at five population monitoring points have been steadily declining. The species is listed as Endangered under the Australian Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*), and assessed as Critically Endangered under IUCN criteria. *Haloragis eyreana* has rather specific habitat requirements, being found in low lying, disturbed areas subject to inundation or water runoff during winter.

We wanted to examine the influence of planting-site proximity to the water table on translocation success. This case study describes a translocation trial that led to the serendipitous discovery of an ideal microsite for plant establishment and ongoing recruitment of this species.

Aim of the translocation

By creating artificial micro-habitats, this translocation trial aimed to examine the influence of planting-site proximity to the water table on translocation success.

Translocation working group and key stakeholders

- Conservation Biology Unit, Botanic Gardens of South Australia – plan and implement the translocation and perform ongoing monitoring and maintenance of the translocation site.
- Threatened Flora Project Officer (Anthony Freebairn), National Parks and Wildlife Service South Australia (NPWSA), Eyre Peninsula – assist with planning and implementation of the trial.
- District Council of Lower Eyre Peninsula – provided machinery and operators for excavation of planting microsites.
- *Haloragis eyreana* Recovery Team and subsequently Ark on Eyre Threatened Flora Recovery Team – oversee planning and implementation of the translocation.

Biology and Ecology

- The species has specific habitat requirements, being confined to disturbed areas (roadsides, road intersections, rail corridors) that are subject to inundation or water runoff during winter. It is often found in low lying areas such as roadside gutters, drains, seepage hollows and crabholes, usually on heavy clay loam soils.
- Readily propagated from seed, cuttings or by tissue culture.
- Seeds are surrounded by a hard, woody fruit containing a germination inhibitor which can be leached from the fruit with water, or counteracted by gibberellic acid treatment (Jusaitis *et al*. 2000).
- Flowers are wind pollinated (Jusaitis *et al*. 2000).
- Regeneration is from seed or as regrowth from rootstocks or suckers (Jusaitis and Freebairn 2010).

Site selection

This trial was located along the Bratten Way, a road that runs through the natural population of *H. eyreana* near Cummins. Sites were chosen within the natural population in order to maximise site suitability for plant establishment, allowing us to focus on the main factor of interest, proximity to the water table.

Translocation proposal

The design for this experiment was submitted to and approved by the *H. eyreana* Recovery Team and was supported by the District Council of Lower Eyre Peninsula.

Pre-translocation preparation, design, implementation and ongoing maintenance

A series of five trenches were excavated at each of four locations along the Bratten Way. Trenches were approximately 0.4-0.5 m deep and 0.7 m wide, and separated by four crests about 5 m long and 0.5 m wide (Figures 1 and 2). Two crests were left at natural soil level (high crests) and two were lowered by scraping about 200 mm of soil from the surface (low crests). All excavated soils were removed from each site.

Haloragis eyreana was micropropagated using explants sourced from eight local provenances (Lee and Jusaitis 2000). (Editor's note: Micropropagation is the propagation of plants by growing plantlets in tissue culture and then planting them out). In August, 2003, ten plants (2-5 cm high) were transplanted onto each crest, a total of 40 plants per location. No planting took place in the trenches. At the same time, 20 plants were transplanted as controls in undisturbed soil near each excavation. Survival and regeneration of *H. eyreana* at the two soil levels (high, low) and at the control sites were monitored annually for nine years. Plant recruitment in the trenches was also monitored.

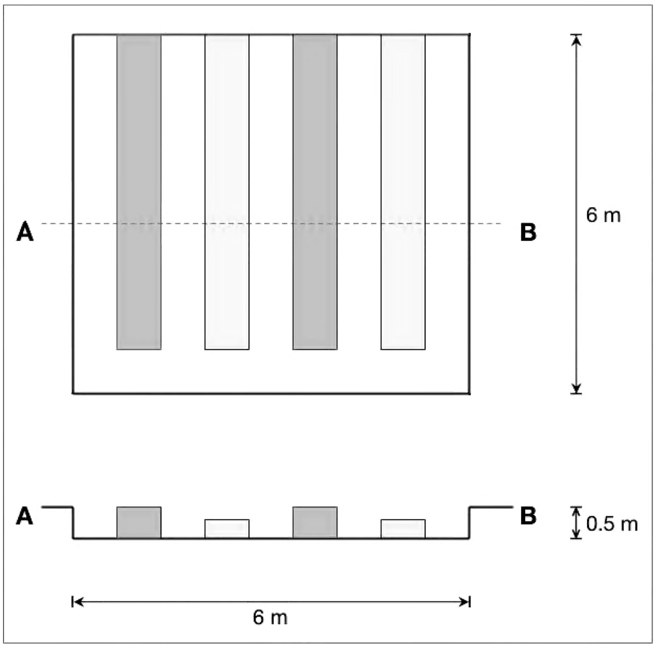

Figure 1. Layout of *Haloragis eyreana* translocation trial showing high (dark) and low (light) crests and interstitial trenches. The lower diagram shows a cross-section through A-B.

Monitoring and evaluation

Although plant survival on low crests and in controls was generally slightly higher than on high crests (Figure 3), the number of original transplants in all treatments declined steadily over 4 years, to when none remained alive (Figure 4). However, during year 3, recruitment of new seedlings and sucker regrowth was observed around the original transplants on all crests. The total number of regenerants did not vary significantly between high or low crests, ranging between 1-5 plants/m^2 over years 4-8. Natural recruitment was also observed in trenches during year 3, and from then the number of plants increased exponentially so that trenches averaged 18 plants/m^2 by year 8 (Figure 5).

Trench plants were more likely to perenniate (survive and grow perennially) from year to year than crest plants. Controls showed no recruitment until the fifth year, averaging 2 plants/m^2 by year 8. The lower recruitment in controls and on crests may be at least partly due to competitive effects of weeds and other herbs, which were less prevalent in trenches (Figure 5). Measurements of soil moisture content demonstrated that trench soils had consistently higher moisture levels than crest or control soils, regardless of time-of-year. Trenches occasionally flooded with water during wet winter periods (Figure 2), but the ensuing transient submergence of plants did not appear to adversely affect their subsequent survival, growth or flowering.

Outcomes

Edaphic amelioration provided an ideal micro-habitat for growth, flowering and recruitment of *H. eyreana*. In 8 years, the population was increased by over 1000 new plants regenerating at four new sites within the population range.

Figure 2. Layout of *Haloragis eyreana* translocation trial showing the four crests (H, L, H, L) and interstitial trenches on the day of translocation. Photo: Manfred Jusaitis

Figure 3. *Haloragis eyreana* transplants a year after translocation onto a high crest. Photo: Manfred Jusaitis

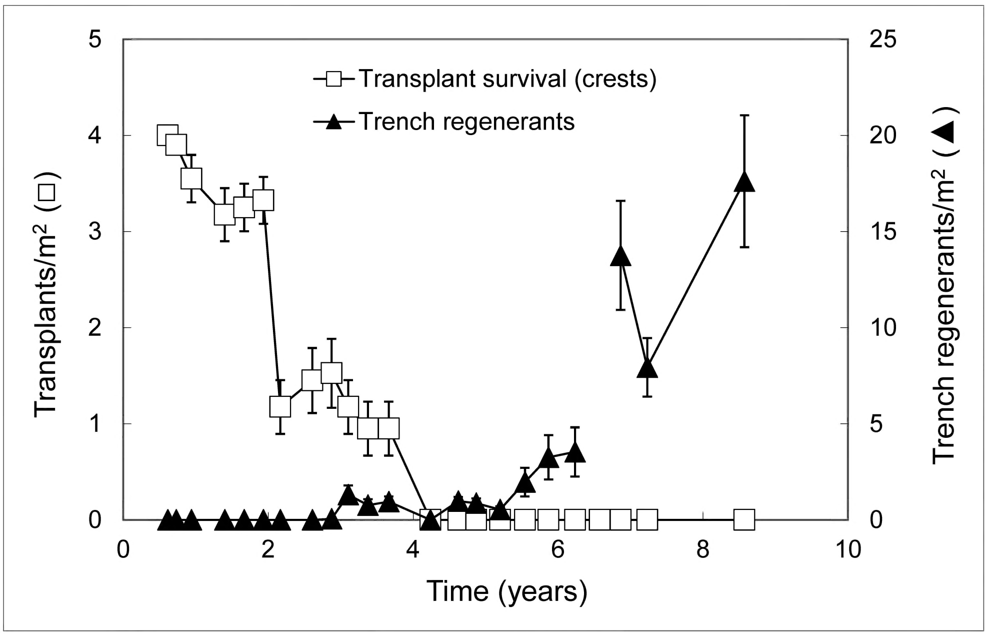

Figure 4. Survival of *Haloragis eyreana* transplants (average of high and low crests at 4 sites) and recruitment of plants in the trenches (average of 5 trenches x 4 sites). In July 2009, the trenches were flooded and regenerants could not be counted (break in the graph). Error bars represent the standard error of the mean (*n* = 16 for transplants and *n* = 20 for trench regenerants).

Figure 5. Natural recruitment of *Haloragis eyreana* in trenches six years after plants were translocated to crests. Photo: Manfred Jusaitis

Excavated trenches provided excellent soil-moisture conditions and protected plants from wind damage and drying. When ideal conditions were provided, plants had no difficulty in regenerating from seed, rootstocks and suckers.

What we learned

- It is possible to establish new populations of this species.
- Natural regeneration of *H. eyreana* was significantly enhanced by edaphic modification of its habitat to produce suitable microsites.
- Trenches supported the best growth, recruitment and regeneration of *H. eyreana*, followed by low crests, then high crests, and lastly controls.
- The improved performance of high crests over controls may be attributable to the additional soil disturbance and vegetation clearance from crests during their construction.
- Construction of low-lying drains, trenches or swales can create suitable micro-habitats that retain and conserve soil moisture to support successful germination and proliferation of this plant.
- The plant appears to respond favourably to a certain amount of soil disturbance, provided weed encroachment is minimized.
- The four translocation locations tested varied considerably in their ability to sustain *H. eyreana*, indicating that proximity to the water table was not the only factor involved. Optimal locations also required appropriate soil structure and moisture-holding capacities, as well as low competitive pressure from weeds and other vegetation.
- Even though our original aim was to only compare high and low crests, longer-term monitoring beyond year 4 revealed the serendipitous discovery that trenches provided the best microsite for regeneration (Jusaitis 2012).

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Threatened plant translocation case study:

Pomaderris delicata (Delicate Pomaderris), Rhamnaceae

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The Species

- Upright perennial shrub.
- Endemic to New South Wales.
- Only known at two sites: a nature reserve south-west of Goulburn and a roadside at Boro South (east of Tarago).

Threatening Processes

- Excessive herbivore browsing (native and feral).
- Climate change – especially prolonged drought.
- Accidental damage to the roadside population during verge maintenance, from spray drift and weed incursion.

Deciding to translocate

Supplementation planting was reasonably successful at the roadside site but plant survival was poor at the nature reserve site, where naturally growing plants had declined greatly in number in the previous decade. With the long-term security of the roadside population uncertain, a decision to create a third population was made.

Aim of the translocation

The aim of creating a new population was two-fold: to reduce the risk of extinction for the species overall and to learn more about how to successfully establish plants (both for future translocations and for supplementation of the existing nature reserve population).

Translocation working group and key stakeholders

- NSW Office of Environment & Heritage (OEH) – to oversee the development and implementation of translocations and the ongoing monitoring and management of translocation sites.
- Australian National Botanic Gardens (ANBG) – to supply plants with known origins and traceable genetic lineages using the Genome Collection Method, and to advise on timing for translocation planting.

Figure 1. ***Pomaderris delicata*** **under cultivation at the Australian National Botanic Gardens. This species was grown from cuttings, flowered and set seed within 18 months. Photo: Joe McAuliffe**

Biology and Ecology

Pomaderris delicata grows in dry open forest dominated by *Eucalyptus sieberi* with either *E. macrorhyncha* or *E. agglomerata* with an *Allocasuarina littoralis* mid-storey on shallow, sedimentary soils. Plants grow to 1.5 m in height. The species regularly flowers in September/October but to date its seed output has been observed to be poor. *Pomaderris delicata,* like other species of the genus, is an obligate seeder. The reason for the rarity of *P. delicata* is uncertain as it occurs in an area with a high diversity of *Pomaderris* species. There may be some impediment to seed production, although regeneration from seed does occur and the populations at both sites are not even aged.

Site selection

Nadgigomar Nature Reserve is the closest protected area to the roadside population where propagation material was obtained, and contained similar vegetation and soils. Management of the reserve was consistent with the translocation because it focussed on flora and fauna management, and plans for prescribed burning could accommodate translocated plants while they established. In addition, park staff were supportive of the work

Translocation proposal

In early 2014, ANBG was contracted by OEH under the Saving our Species program to attempt the production of 200 plants from as many genetically different individuals as possible. An enhancement proposal was then prepared for both sites following the Australian Network for Plant Conservation's (ANPC) Translocation and Germplasm guidelines (Vallee *et al.* 2004, Offord and Meagher 2009). Following the near failure of the supplementation planting at the nature reserve (where only 3 of 44 plants survived), two additional plantings occurred at an alternative site within the reserve, which was more sheltered than the first. Survivorship was improved at that site, plants have flowered and produced seed, but occasional deaths of established plants still occur.

The techniques developed from the enhancement planting were used to produce plants for the translocation sites. Cutting material to establish the new translocation site was obtained from the roadside population, which was larger and healthier than the nature reserve population.

A translocation plan was prepared as a necessary requirement of licensing for the project – it was peer reviewed.

Pre-translocation preparation, design, implementation and ongoing maintenance

In situ

The planting was done in August, at a time when soils were moist and stress on plants was presumably low. Two sites were chosen within the reserve, encompassing a range of microhabitats (slope, aspect and tree cover). Guards were placed around plants to restrict browsing by macropods and deer. Plants were watered by hand every two weeks until substantial rain occurred in spring.

Ex situ

The following issues influenced the design of the enhancement planting and plant production:

- Every wild plant was assumed to be a genetic individual. *Pomaderris delicata* is not known to reproduce from root suckers, and work by a CSIRO summer student confirms that the species is diploid (i.e., has two complete sets of chromosomes, one from each parent).
- The autumn-winter period was likely to be best for obtaining cuttings, based on ANBG production history and previous experience.
- The field collecting method was influenced by the number and size of plants in each population.
- Ensuring each genotype collected was traceable from the propagation and production phase through to translocation ready plants.

Two sampling methods were employed:

1. Individual samples: Robust individual wild plants with more than 10 removable cuttings were sampled and managed separately from all others by allocating a unique alpha-numeric identifier (collection number). Due to the low number of plants in this category and non-suckering habit, no minimal distance between plants was employed.
2. Multiple samples: Individual wild plants with less than 10 removable cuttings that were less than 10 m from adjacent plants were sampled and managed as one collective accession. When these plants were separated by more than 10m they were given a separate collection number.

- As per standard threatened species collecting protocols, we restricted the total material taken from an individual to 10% of the plant's vegetative growth.
- Throughout the sampling, protocols were employed to ensure key hygiene practices were in place to avoid the risk of pathogen transfer.

As additional insurance, the ANBG retained representatives of all clones in the Living Collection, in case of failure of the enhancement plantings, further decline in extant populations and as stock plants for future production for subsequent plantings.

Subsequent actions

The plantings have been monitored regularly, fortnightly after planting and approximately monthly thereafter. Surviving plants were watered in the weeks after planting and during summer if unusually dry.

Subsequent survey has revealed an additional wild population of about 60 plants, which have been guarded with wire and stakes to restrict browsing by macropods and deer.

Outcomes

Enhancement plantings at both sites are surviving, flowering and producing seed, despite occasional deaths. The best survival and subsequent growth occurred when new plants were placed within the existing population at the roadside site, although survival was also surprisingly good on an exposed roadside batter comprising B horizon soils. No recruitment has been observed yet.

The translocation into Nadgigomar Nature Reserve failed rapidly. All plants had died by early October, two months after planting, despite favourable conditions for plant growth (i.e., soils were not especially dry during that time). The roots of five plants were sent to the Royal Botanic Gardens Sydney for testing for *Phytophthora* but all were negative.

What we learned

Finding a suitable planting site has been challenging. Survival seems to be better within existing sites in sheltered situations, but has also been very good on an exposed road batter made up of subsoil. For a second translocation attempt at Nadgigomar Nature Reserve we will choose a site that already has at least one species of *Pomaderris* growing on it. We have noticed that where one *Pomaderris* species grows there are often several. Mycorrhizal associations have not been recorded, to our knowledge, for this genus, but perhaps cannot be ruled out.

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Threatened plant translocation case study: *Prostanthera eurybioides* (Monarto Mintbush), Lamiaceae

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The Species

- Low spreading shrub growing to less than 1 metre.
- Endemic to South Australia.
- Twelve extant natural populations that occupy an area of approximately 466 hectares.

Threatening Processes

- Small isolated populations.
- Lack of recruitment.
- Inappropriate disturbance regimes (e.g. infrequent fire).
- Grazing by kangaroos and pest herbivores.

Deciding to translocate

Prostanthera eurybioides has a limited distribution in two disjunct areas separated by 160 km, Monarto (near Murray Bridge) and the Mt Monster area in the south east of South Australia. The population size is estimated at 2,084 individuals; 1,175 at Mt Monster (152 planted) and 909 at Monarto (682 planted). There is very little evidence of recruitment at Monarto, with this population experiencing senescence and decline. By comparison, in 1992, an estimated one-third of individuals in Mt Monster Conservation Park were juveniles (Davies 1992).

Genetic and seed germination studies (Ainsley *et al.* 2008a, 2008b) were undertaken to investigate the lack of recruitment at Monarto. Genetic work showed

Figure 1. ***Prostanthera eurybioides*** **flower. Photo: Chris Obst**

that Monarto populations maintain high diversity and low inbreeding and are not at risk of extinction due to genetics. Germination studies found the seed to have low viability and seed dormancy in the form of a mericarp plug which acts as a barrier to germination. (*Editor's note: You can see a great depiction of what a mericarp plug is in Figure 3*).

Previously there had been 1,454 *P. eurybioides* plants translocated in the Monarto area: 423 from seed (1996, 1998-99), 1000 from cuttings (2003) and 31 from tissue culture (2007).

Despite these translocations, by 2013 the planted population at Monarto was only approximately 350 and the remnant population had declined significantly. It was clearly time to take further action at Monarto.

In 2013 the SA Seed Conservation Centre was asked to test the viability of *P. eurybioides* seed collected from Monarto sites, determine the best germination method for use by nurseries, and to use this method to produce a large number of plants for translocation.

Aim of the translocation

- To successfully establish 500 mature adult plants, raised from seed, into 10 new sites with secure tenure.
- To explore the response of planted *P. eurybioides* to management treatments (position within remnant vegetation, type and size of plant guard, weed control pre- and post-planting, watering through summer), and subsequently inform future translocations.

Translocation working group and key stakeholders

- SA Murray-Darling Basin Threatened Flora Recovery Team (SAMDB TFRT).
- SA Seed Conservation Centre – research.
- Mount Lofty Botanic Gardens – seedling propagation.
- Aboriginal Learning on Country, Zoos SA – planting, maintenance and survey assistance.

Biology and Ecology

- Flowers September to November.
- Pollinator is unknown, the introduced honey bee has been observed regularly visiting flowers.
- Seeds dehisce (i.e., burst open) December to January.
- Seeds consist of four mericarps enclosed by a persistent calyx.
- Removal of mericarp plug results in improved germination.
- Hot dry summer (hot temperatures help overcome dormancy associated with mericarp plug and seed embryo); germination usually occurs following autumn/winter rainfall.
- Plants associate with rocky granitic outcrops.
- Occurs in low open mallee woodland or tall shrubland often with *Melaleuca uncinata*.
- Occurs on sandy loam to loam, pH 6-7.

Site selection

Sites were identified in the Monarto area, within two km of existing remnant populations. Historical records of *P. eurybioides* were also used to inform planting locations. Locations with secure tenure were identified in two areas of Kinchina Conservation Park (CP) and private land protected by a Heritage Agreement (HA) (covenanted land). These areas supported habitat suitable for *P. eurybioides* and were being actively managed for rabbits and weeds.

Figure 2. Spreading *Prostanthera eurybioides* shrub. Photo: Clive Chesson

Nine sites were selected in Kinchina CP, and one in the HA. The HA property has the largest remnant population of *P. eurybioides*, while the Kinchina sites have historic or remnant records nearby.

Translocation proposal

A formal plan was not prepared for this translocation. The translocation process was directed by the SAMDB TFRT following their approval of a report prepared on the seed collection, viability studies and treatment through to propagation. Data on the translocation was included in the region's translocation database and monitoring was undertaken for each site.

The Recovery Team approved the translocation as it aligned with recovery plan targets to double the population size in five years by planting from seed stock into secure sites.

Pre-translocation, preparation design, implementation and ongoing maintenance

Seed was collected from seven sites (seed batches) across Monarto (within a 55 ha area of occupancy), tested for viability and treated with a dry heat pulse (80˚C) / smoked water combination. Seedlings emerged within 2-3 weeks of sowing and were transferred to tubes. Each tube was labelled according to its original seed batch. In all, 413 seedlings were produced; 333 of which were of suitable size for planting in the first year.

In June 2014 the 333 seedlings were planted out. Planting batches comprised a mix of the seven seed batches. Mixing the seed was deemed acceptable due to the close proximity of the Monarto remnant sites to each other, the fact that none of the populations are large and that mixing would potentially enhance genetic diversity. The 10 planting sites varied in size from 12 to 85 plants.

At nine of the sites (Kinchina sites only) weeds were treated in one metre spray circles around the planting zone (glyphosate), at least two weeks before planting. Seedlings were planted into a depression to increase water holding potential, a fertiliser tablet was provided and a corflute guard was installed. Plants were watered in.

In 2015, a further 80 seedlings were planted into one of the Kinchina CP sites. Total planting across both years was 413 plants. These plants received the same treatment, except that both a corflute and larger mallee mesh guard were installed together in the second year.

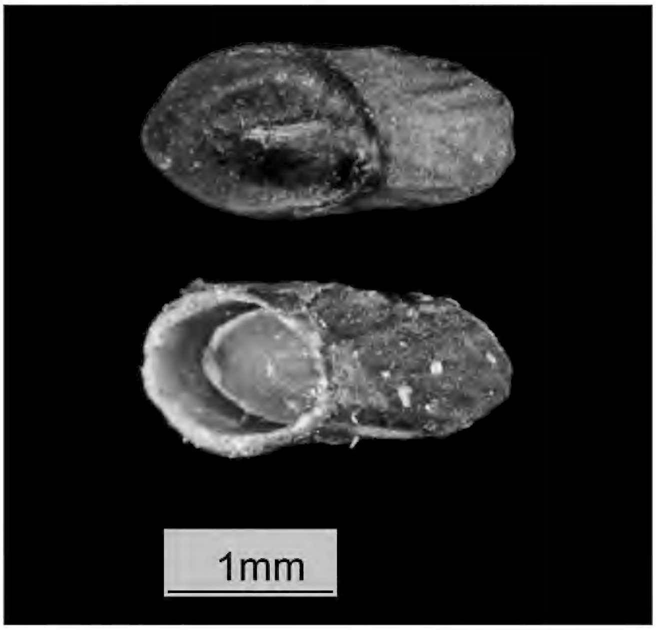

Figure 3. Seed of the Monarto mint bush with mericarp plug intact (top) and removed (bottom). Photo: Phil Ainsley

Monitoring and evaluation

Monitoring of plant survival, health and flowering was undertaken for three years following the translocation.

By September 2014 the survival rate was 63%, with significant loss at two sites due to competition with established mallee vegetation, no watering to date, and a very dry spring. By April 2015, 46% had survived. With supplementary planting in June 2015 (a further 80 seedlings), the count in September 2016 was 218 plants (52% survival rate across both plantings). Survival of the second-year plants was much higher. In the second summer following planting, approximately 70% of the plants were flowering.

Subsequent actions

- Watering occurred twice over the first summer for all sites.
- Hand weeding occurred within the guards for the first two years.
- Mallee mesh wire guards (800 x 350 mm) replaced corflute guards after 12 months, as plants were outgrowing the guards.

Outcomes

- The original target of 500 plants was not achieved, due to the low viability of the 2013 seed and high plant mortality.
- Propagation methods suitable for use by community nurseries were developed from this process and a community propagation workshop was held in 2016, attended by 25 people.

Figure 4. Planted *Prostanthera eurybioides* flowering at 12 months. Photo: Kylie Moritz

Figure 5. 1000 *Prostanthera eurybioides* seedlings for planting in 2018. Photo: Matt Coulter

What we learnt

Seedlings planted close to established vegetation did not survive, presumably due to water stress and competition from mature plants.

- Plants need to be watered through the first two summers.
- Guards are essential as the plants are highly palatable and seemingly targeted for 'rubbing' by herbivores.
- 2017 saw very high seed production across Monarto, and collections were made from all sites. Testing indicates that this seed is highly viable. Subsequently 1000 plants have been propagated from seed, for translocation in June 2018.
- Seed collection should be timed during high seed production years to achieve higher seed viability.

Editor's note: This is the second article to be published by APC on translocation of Prostanthera eurybioides *in recent times. You may also be interested in the article on* Prostanthera eurybioides *translocation by Manfred Jusaitis in the previous issue of APC (27-1).*

References and further reading

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Threatened plant translocation case study:

Translocation of threatened flora for the Warrell Creek to Urunga upgrade of the Pacific Highway, Mid North Coast NSW

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The Species

Six threatened species impacted by the highway upgrade were translocated:

- *Marsdenia longiloba* (Slender Marsdenia).
- *Dendrobium melaleucaphilum* (Large-flowered Spider Orchid).
- *Alexfloydia repens* (Floyds Grass).
- *Niemeyera whitei* (Rusty Plum).
- *Hickesbeachia pinnatifolia* (Red Bopple Nut).
- *Artanema fimbriatum* (Koala Bells) (recommended for threatened species listing).

Threatening Processes

Threatening processes affecting these species include habitat clearing, timber harvesting, small population size, poor understanding of species life cycle and ecology, plant collectors (Spider Orchid) and sea level rise (Floyds Grass).

Deciding to translocate

A translocation feasibility assessment was undertaken before deciding to translocate each species. The main factors considered were:

- Technical feasibility, including previous translocation results for the same or similar species.
- Potential for generation of new and useful scientific information.
- Availability of receival sites with suitable habitat and security of tenure.

Aim of the translocation

The purpose of translocating threatened species in a developmental context is to avoid decline in population number and genetic diversity as a result of development impacts. The overall aim of translocation is to establish new or enhanced populations that are self-sustaining over the long term. This is usually effected by a combination of salvage transplanting, propagation and introduction, and habitat restoration. As well as assisting the maintenance of population number and genetic diversity, translocation can improve understanding of threatened species' life history and ecology, through attempts to manipulate and maintain populations by different treatments. A further aim is to develop reliable translocation/introduction methods for each species.

Translocation working group and key stakeholders

NSW Roads and Maritime Services (RMS), NSW Office of Environment and Heritage, Commonwealth Department of Environment and the Principal Contractors (Pacifico (Aciano – Ferrovial Joint Venture) and Lend Lease), and Ecos Environmental Pty Ltd.

Biology and Ecology

- Slender Marsdenia – small vine inhabiting the lower and mid strata of moist open forest; population structure partly clonal, seed production rare and possibly disrupted by decline in pollinators.
- Large-flowered Spider Orchid – epiphytic orchid found in swamp forest and rainforest.
- Floyds Grass – perennial, stoloniferous grass inhabiting the margins of coastal estuarine creeks.
- Rusty Plum – medium-sized rainforest tree of lowland rainforest and margins of moist open forest.
- Red Bopple Nut – small rainforest tree of lowland rainforest.
- Koala Bells – annual to short-lived perennial herb of coastal floodplain forest.

Site selection

Plants were sourced from sites impacted by the Warrell Creek to Urunga upgrade of the Pacific Highway, Mid North Coast NSW. The most important criterion in selecting recipient sites for each species was close resemblance between habitat at the recipient and original (donor) sites, including soil, topography, vegetation type and microclimate. All sites were located in the forested road reserve or other RMS property and spread out along the 42 km project corridor. Numbers of recipient sites established for each species were as follows: Slender Marsdenia, 7 (including an experimental area divided into different treatment blocks); Rusty Plum, 2; Red Bopple Nut, 1; Floyds Grass, 2; Spider Orchid, 2; and Koala Bells, 4.

Figure 1. Excavating a soil-root ball around a small Rusty Plum tree during transplanting. Photo: Andrew Benwell

Figure 2. The Rusty Plum in figure 1 was pruned back to a bare trunk. This is the same tree two years later showing vigorous regrowth. Photo: Andrew Benwell

Translocation proposal

The translocation proposal described actions to salvage impacted individuals of threatened species, re-establish them in corresponding habitat, enhance translocated populations (where possible) by introducing additional propagated plants and restore/maintain good quality habitat. A Translocation Plan (Ecos Environmental 2014, 2016) was prepared, including pre-translocation assessment of the site and each species, translocation proposals for each species, and post-translocation measures such as maintenance and monitoring.

The project would run for five years and results would be assessed before deciding whether to continue monitoring and maintenance. RMS divided the highway project into northern and southern stages for construction by different contractors. Construction and translocation began about 18 months apart in the two stages, in 2013 and 2015.

Pre-translocation preparation, design, implementation and ongoing maintenance

Salvage translocation was carried out using the direct transplanting method, which involves excavation, transport to the recipient site and replanting in one action rather than as a gradual process. Excavation is carried out with an excavator or with hand tools if plants are small. The objective is to remove the shoot system and enough of the root system to enable regeneration and plant survival. Basic horticultural measures such as pruning and watering are applied to minimise transpiration stress and maximise survival.

Site preparation included marking out planting areas and removal of weeds such as Lantana where present. The Floyds Grass site was covered by exotic grass under a canopy of native trees. To prepare this site, ground layer plants and topsoil seedbank were stripped off with an excavator to a depth of 5-10 cm to minimise weed competition. Enough alluvial topsoil remained for plants to establish.

Previous translocations of Slender Marsdenia suggested this species was negatively affected by addition of fertiliser in the field, although it responded positively to fertiliser under pot cultivation. To investigate this observation under controlled conditions, a field experiment was designed to measure the performance of Slender Marsdenia plants introduced with and without addition of fertiliser. The fertiliser treatment was compared in direct transplants and plants propagated from seed and vegetatively (Table 1).

An effective method was developed for translocating epiphytic orchid species that consisted of moving orchid plants with a section of the bark or branch substrate so a substantial amount of the root system remained intact. This was carried out with a saw or hammer and chisel. The piece of bark or branch was then attached to a suitable tree trunk or branch with wire. Using this simple method, the orchids continued to grow and flower without any sign of adverse effects.

Figure 3. Slender Marsdenia stem shoot 3 years after being transplanted. The wire cage is to exclude herbivorous marsupials, provide an initial climbing frame and facilitate monitoring. This individual is in the experimental area and received fertiliser (12 month slow release for natives). Photo: Andrew Benwell

Figure 4. Spider Orchid removed with roots intact on its bark substrate and reattached to bark of the same species at the recipient site. Photo: Andrew Benwell

Table 1. Treatments applied to Slender Marsdenia.

Treatments	Factor 1 introduction mode	Factor 2 fertiliser treatment	Factor 3 propagation type
Treatment 1	direct transplant	no fertiliser	n/a
Treatment 2	propagated	fertiliser	seedling
Treatment 3	propagated	fertiliser	vegetative
Treatment 4	propagated	no fertiliser	seedling
Treatment 5	propagated	no fertiliser	vegetative

As previous results suggested that fertiliser had a negative effect, fertiliser was not applied to direct transplants of Slender Marsdenia. This was done to maximise survival rate, a key objective of the translocation project. Results were compared with previous translocations where fertiliser was applied.

Subsequent actions

Follow-up watering was carried out for three months and shade screening was erected to protect Rusty Plum. Monitoring was conducted 3 monthly in the first year and 6-monthly thereafter. Data recorded included plant height, insect grazing, disease, new shoot growth, flowering, recruitment and plant condition on a scale of 0-5. Weed removal and thinning of native regrowth were carried out every six months at the Floyds Grass site.

Figure 5. Red Bopple Nut showing vigorous regrowth from the end of pruned branches 3 years after transplanting. Photo: Andrew Benwell

Outcomes

Survival rates after three years were high for all species except for Koala Bells, but the life cycle of this species appeared to be essentially annual, or occasionally perennial, and disturbance (baring of soil) was required to stimulate regeneration from seed. Flowering and seed production were observed in transplants of all species within three years, Koala Bells within three months.

After 3 years, slow release fertiliser had a negative effect on the survival of Slender Marsdenia and plants propagated from seed had a higher survival rate than vegetatively propagated plants.

Propagation and introduction for population enhancement were implemented for four of the six species, where seeds or cuttings were available. Longer term outcomes remain to be monitored (Table 2).

Figure 6. Floyds Grass recipient site 3 years after removal of exotic grass ground cover and restoration of native species including Floyds Grass indicated by pink tags. Photo: Andrew Benwell

Table 2. Survival and flowering/seeding rates, according to species.

Species	Northern stage Survival 3 yrs	*N*	Southern stage Survival 3 yrs	*n*	Flowering/ seeding	Population enhancement
Slender Marsdenia	68%	104	74%	175	1 plant	implemented
Spider Orchid	95%	55	100%	2	yes	
Floyds Grass	-	0	94%	54	yes	implemented
Rusty Plum	100%	3	88%	7	no	implemented
Red Bopple Nut	100%	1	-	0	yes	
Koala Bells	3%	35	13%	16	yes	implemented

What we learned

- The species translocated can be re-established with high survival rates using the direct transplanting method.
- Results of the Slender Marsdenia experiment supported the hypothesis that addition of fertiliser negatively affects growth and survival in translocated plants of this species.
- Other aspects of Slender Marsdenia life cycle and response to transplanting remained enigmatic. Twelve different response syndromes in transplanted individuals were identified, but are difficult to explain. Seedlings grew much more strongly than vegetatively propagated plants.
- Floyds Grass is relatively easy to translocate, although a poor competitor with the native grass *Ottochloa gracillima* which limits its spread locally; survives flooding and king tide inundation.
- An effective method was developed for translocating epiphytic orchid species.
- Koala Bells is a disturbance regenerator with an annual or occasionally short-lived, perennial life cycle.

References and further reading

Ecos Environmental (2014, 2016). *Warrell Creek to Urunga Upgrade of the Pacific Highway Threatened Flora Management Plan*. Report to Roads and Maritime Services, Grafton, NSW.

Figure 7. Koala Bells. This is a propagated population enhancement plant, which typically flowered within 3 months of being introduced. Recruitment was recorded at one of the recipient sites with sections of bare soil. Photo: Andrew Benwell

Threatened plant translocation case study:

Involvement in the Royal Botanic Gardens Victoria's Orchid Conservation Program by volunteers from the Australasian Native Orchid Society Victoria Group

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Orchids

Orchids are one of the most charismatic and diverse plant families with over 26,000 species worldwide (WSPF 2018). Australia is home to more than 1800 (Backhouse *et al.*, 2016) species and subspecies of orchid, with the majority being terrestrial species found predominately in the temperate south. Victoria has in excess of 400 species of native orchids with many occurring nowhere else on Earth. Orchid habitat in Victoria varies from alpine peaks to semi-arid mallee, swamps, native grasslands, heath lands, and eucalypt forests of all types. The majority of our native orchids emerge from an underground tuber in autumn, flower in late winter-spring and set seed before the summer, when they retreat back to their underground tuber. All orchids are reliant on one or more species of mycorrhizal partner (Rasmussen 1995) to germinate in the wild, and are often pollinated by only one or a few species of insect (Tremblay *et al.* 2005). Successful conservation translocations (supplementations, reintroductions and introductions) of these plants typically require a thorough understanding of their ecology including pollinators and mycorrhizal fungi (Reiter *et al.* 2016).

Reasons for conservation translocation

Orchids represent only 6% of all plants in Australia, yet alarmingly 17% of all plants listed under the *Environment Protection Biodiversity and Conservation Act 1999* (*EPBC Act*) are orchids, more than any other plant family. While some species were naturally rare, the majority have had wider distributions and have undergone range declines over the past 100 years. The causes of decline include: historic land clearing, competition by introduced weeds, grazing by introduced and native animals and historically illegal poaching (Reiter *et al.* 2016). Due to reduced numbers, many species are now vulnerable to inbreeding depression, climate change and inappropriate fire regimes. Without targeted conservation efforts, including conservation translocation, many of these species are likely to become extinct.

Aims of the Royal Botanic Gardens Victoria (RBGV) Orchid Conservation Program

The RBGV Orchid Conservation Program aims to prevent extinction by:

- Storing a genetically diverse representation of seed and mycorrhizal fungi of all Victorian threatened orchids.
- Propagating suitable numbers of each of our threatened orchids for conservation translocation.
- Undertaking conservation translocations including supplementation, reintroduction and introduction of these species when species have declined to unsustainable levels.

The Orchid Conservation Program conducts research on all aspects of orchid ecology, including pollination, mycorrhizal associations, propagation, demographics and conservation translocation techniques. RBGV works with stakeholders and partners to provide advice on the conservation of orchids.

The stakeholders and partners

The Orchid Conservation Program is a collaboration between many stakeholders and partners. Working across multiple levels of government, not for profit organisations and community groups enhances the outcomes of the program. Partners include: Royal Botanic Gardens Victoria, Adelaide Botanic Gardens, Parks Victoria, Department of Environment Land Water and Planning, Trust for Nature, Australian Network for Plant Conservation, The Australian National University, Office of Environment and Heritage, Murray Local Landcare Services, Wimmera Catchment Management Authority, Nillumbik Shire, Project Platypus, Australasian Native Orchid Society Vic Branch (ANOS) and many volunteer groups.

The Australasian Native Orchid Society involvement

ANOS Vic has been a key community partner in the Orchid Conservation Program since its inception (Reiter *et al.* 2012). On a yearly basis volunteers contribute over 2500 skilled hours of work on the RBGV Orchid Conservation Program and many more on local community orchid conservation activities with other partner organisations. Many of the volunteer's field activities are co-ordinated through ANOS Vic's own volunteer Orchid Conservation Officer. Potential volunteer involvement activities are taken to ANOS Vic's committee at the start of the year to allow adequate planning of events. Volunteers have varying levels of skills when starting with the program and an important part of their induction is therefore training. Training of the volunteers includes not only the tasks that they are performing but providing background knowledge on the species they are working with. Learning continues during the activities and sharing of knowledge between volunteers and stakeholders is ongoing. Activities onsite at the RBGV laboratory and nursery include: germination counts, data entry, flasking seedlings, and potting orchids. Field activities include: surveys, monitoring, planting for translocations, weeding at important sites, and surveys for orchid pollinators. Importantly, with translocations we make a concerted effort to take volunteers back to these sites to assist with monitoring and post-translocation maintenance, allowing everyone to see the results of their hard work. Below are three examples of ANOS Victoria's involvement with conservation and translocation of over thirty species of threatened orchids as an integral part of the Victorian Orchid Conservation Program.

Figure 1. A) *Caladenia fulva*, B) *Thelymitra mackibbinii*, C) *Caladenia colorata*. Photos: Noushka Reiter

Figure 2. A) Monitoring set up *Caladenia colorata* conservation translocation, B) volunteers caging *Caladenia fulva* conservation translocations, C) volunteers potting orchids in the RBGV nursery, D) volunteer hands planting *Caladenia fulva*, E) volunteers planting *Caladenia versicolor*. Photos: Noushka Reiter (A, C, D, E) and Charles Young (B)

The Colourful Spider-orchid (*Caladenia colorata* D.L.Jones)

Caladenia colorata has a single green leaf, and produces one to two flowers between late August and mid-October (Figure 1 C). Flowers are usually a pale yellow, though red, pink and multi-coloured forms can be observed. There are fewer than 1,000 plants occurring in five wild populations within western Victoria. In South Australia there are 851 plants known from 11 populations and only two of these populations contain more than 100 individuals. All populations, and in particular populations supporting only small numbers of individuals, are highly vulnerable to extinction. In Victoria , *C. colorata* inhabits *Eucalyptus incrassata* Labil. woodland (Lowan Sands Mallee) and *Eucalyptus leucoxylon* F.Muell. dominated open woodland (Shallow Sands Woodland). Creating additional self-sustaining populations will reduce the species vulnerability to demographic and environmental stochasticity, thereby decreasing extinction risk. *Caladenia colorata* is listed as endangered under the federal legislation: *EPBC Act 1999* and threatened under state legislation *Flora and Fauna Guarantee Act 1988 (FFG Act)*. There is no current national recovery plan for this species across its known range, the recovery plan was placed on the commenced list in 2009. The regional recovery plan (Obst 2005) for *C. colorata* identifies research on life stages, long term monitoring, supplementation, and in particular creating new populations, as recovery actions.

The Orchid Conservation Program initiated work on this species in 2009 at which time the species was only know from one site in Victoria. ANOS Vic have taken part in community surveys (Figure 2) for this species in western Victoria between 2009 and 2016, with these surveys leading to the discovery and mapping of an additional four populations. Symbiotic propagation work was commenced along with pollinator surveys (Reiter *et al*. in review) and threat mitigation including Veldt grass control by partner organisations. The species was introduced back into four sites between 2013 and 2017 on private Trust for Nature covenanted property with the help of enthusiastic volunteers from ANOS Vic, landholders and stakeholders. ANOS Vic volunteers assisted with tagging individual plants (for later monitoring) (Figure 2), caging and site maintenance. To date 772 plants have been introduced since 2013.

The average leaf emergence across the four populations in 2017, of those plants first introduced, is 61% +/- SE (standard error) [14%], with flowering (many had double flowers) at 101% +/- SE [27%] and a pollination rate of 30%+/- SE [5%]. Since 2016, the populations have had recruits (through seedlings and tuber reproduction), with the proportion of recruits compared to those plants originally planted at 33% +/- SE [19%] of the origin populations.

The Tawny Spider-orchid (*Caladenia fulva* G.W.Carr)

Caladenia fulva has a single leaf and produces one to two cream-coloured flowers in August to early October (Figure 1 A). *Caladenia fulva* is known from between 600-1000 plants in the wild. Prior to landscape-scale disturbance from gold exploration and mining, *C. fulva* is likely to have been more abundant with numbers in the thousands in the Stawell-Ararat Box Ironbark area. *Caladenia fulva* is listed as threatened under the *Flora and Fauna Guarantee Act 1988* and endangered under the *Environment Protection Biodiversity and Conservation Act 1999*. The National Recovery Plan (Duncan and Coates 2010) for *C. fulva* identifies re-introduction, and

in particular creating new populations, as a recovery action. Conservation objectives for this species include:

- Measure population trends and responses against recovery actions.
- Establish a seed bank and determine seed viability.
- Establish plants in cultivation to safeguard against destruction of wild population.
- Select and evaluate potential conservation translocation sites.
- Translocate and monitor plants from cultivation.
- Identify opportunities for community involvement.

ANOS Vic has been involved in surveys for new populations, monitoring, assistance with propagation onsite at the RBGV, planting and maintenance at translocation sites (Figure 2). The species was introduced back into five subpopulations between 2015 and 2016 on private Trust for Nature covenanted property with the help of enthusiastic volunteers from ANOS Vic, Stawell Field Naturalist members, landholder and stakeholders. So far 451 plants have been introduced since 2015, with a leaf emergence in 2017 (across the five populations) of 92 % +/- SE [3%] with flowering, natural pollination and seed set observed across all introduced subpopulations.

The Brilliant Sun-orchid (*Thelymitra mackibbinii* F.Muell)

Thelymitra mackibbinii has one dark green leaf and produces one to two dark purple flowers (Figure 1 B) between September and October. *Thelymitra mackibbinii* inhabits the Box-Ironbark forests of Victoria and was more abundant in the Stawell–Bendigo-Ararat area, prior to landscape-scale disturbance from gold exploration and mining. *Thelymitra mackibbinii* is known from just 36 naturally occurring wild plants spread across three disjunct sites. *Thelymitra mackibbinii* does not self-pollinate and requires the aid of bees to transfer pollen (N. Reiter pers. obs). All known populations are reserved. *Thelymitra mackibbinii* is listed as threatened under *FFG Act 1988* and Vulnerable under the *EPBC Act 1999*. The national Recovery Plan (Duncan and Coates 2010) for *T. mackibbinii* identifies reintroduction, and in particular creating new populations, as a recovery action. Recovery actions include:

- Measure population trends and responses against recovery actions.
- Establish a seed bank, and improve seed viability through outcrossing trials.
- Establish plants in cultivation to safeguard against destruction of wild population.
- Selecting potential reintroduction sites.
- Introduce and monitor plants from cultivation.
- Identify opportunities for community involvement.

ANOS Vic and local volunteers have been involved in surveys for new populations, assistance with propagation at the RBGV, applying for funding, monitoring, fencing conservation translocation sites, caging, monitoring translocated plants, and planting new populations of *Thelymitra mackibbinii* grown from seed. The species was introduced back into two sites in the Stawell area (over three translocations) between 2013 and 2017 on a Parks Victoria Reserve, with the help of enthusiastic volunteers from ANOS Vic, Stawell Field Naturalist members, landholders and stakeholders. To date 147 plants have been introduced since 2013, with a leaf emergence in 2017 over the three translocations of 73% +/- SE [13%] with 31%+ /-SE [9%] flowering and 32% +/- SE [11%] pollination.

Acknowledgements

We would like to acknowledge the efforts of all the volunteers that work with the Orchid Conservation Program. We would like to thank the following bodies for financially supporting the Orchid Conservation Program: NSW Saving our Species Fund, Hermon Slade Foundation, National Landcare Program, Victorian Government Department of Environment Land Water and Planning, the Greater Grampians Regional Biodiversity hub funded through DELWP, Portland Aluminium/Alcoa, donations of individuals and foundations including the Australian Orchid Foundation, The Australian Communities Foundation, ANOS Vic, local community groups and amazing individuals.

For further information about the Orchid Conservation Program go to: https://www.rbg.vic.gov.au/science/projects/orchid-conservation

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News from the Australian Seed Bank Partnership

Note from ASBP: In this issue of APC, the News from the ASBP focuses on a specific translocation of *Hibbertia puberula* subsp. *glabrescens*, a project led by ASBP partner the Australian PlantBank. This is just one of the many efforts made across the Partnership to improve the trajectories of threatened plant species using seed collected from across Australia.

Assisted run(a)way: translocation planning to secure the Bankstown Hibbertia

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Species background

The urban development and settlement pattern of Sydney has resulted in significantly reduced, and highly fragmented remnant native vegetation. Despite this vegetation fragmentation, isolated populations of threatened plants still occur and are now surrounded by urban development. The critically endangered Bankstown Hibbertia (*Hibbertia puberula* subsp. *glabrescens)* is an interesting 'urban survivor' and only known from a small population of <100 individuals occurring at a managed open grassland adjacent the Bankstown Airport runway.

Despite being a secure site with sympathetic planning and management, this single extant population is at high extinction risk through threats such as; stochastic events (disease and extreme weather), *Phytophthora* root rot disease, invasive weeds and uncertainty around long term management and airport operations. In response to this extinction risk, the Bankstown Hibbertia has been identified by the Office of Environment and Heritage (OEH) as a priority for translocation and establishment of additional self-sustaining populations at selected recipient sites to increase its distribution, under the 'Saving our Species' program.

Translocation planning for a critically endangered species growing in the highly urbanised Sydney region presents some significant challenges. Here we report on the extensive investigative work and preliminary ecological and genetics studies completed by the recovery team to produce a 'best practice' translocation plan, consistent with the ANPC Translocation Guidelines (Vallee *et al.* 2004).

Ecology and habitat

Bankstown Hibbertia is a prostrate shrub with attractive yellow flowers which occur from October to December. *Hibbertia* species are primarily pollinated by bees (NSW Scientific Committee 2010), but many have specialised mechanisms requiring particular bee species (Bernhardt 1984; Horn 2007); beetles and syrphid flies (hoverflies) are also possible pollinators. However, the degree of pollinator specificity and breeding system for Bankstown Hibbertia is unknown. Seed set is during the summer months with peak ripening and release in November/December. The shiny dark brown seeds (1.5-2 mm long) are most likely ant dispersed and form a persistent soil seedbank.

Figure 1. Bankstown Hibbertia in natural habitat with native grasses, displaying 'layering' habit as branches contact the ground. Photo: Peter Cuneo

It is unknown whether this species is capable of resprouting after fire or is an obligate seeder. Field observations indicate that mature plants appear to 'layer' when branches encounter the soil surface (Figure 1). This characteristic indicates that clonality is likely to be extensive across the population, making it hard to determine between individual mature plants, layer/sucker growth and seedlings.

Key to developing a translocation strategy are detailed observations of the surrounding vegetation, co-occurring species and biophysical characteristics. In the case of

Bankstown Hibbertia, the original vegetation structure no longer exists, making it difficult to precisely determine the original vegetation type. However, a combination of soil/geology and adjacent remnant vegetation mapping was used to determine that the vegetation type would have most likely have been Cooks River/Castlereagh Ironbark Forest.

Seed collections and germination

The Sydney region is rich in *Hibbertia* species which commonly occur on sandstone substrates, and are routinely propagated from tip cuttings. Seed collections were also considered to be an essential component of *ex situ* conservation measures for the Bankstown Hibbertia. Due to sequential seed ripening and seasonal variations, it took two years and repeated site visits to gather an adequate quantity (~2000 seeds) for back up long-term storage and provide for propagation (Figure 2). Seed dormancy in Hibbertia species appears to be complex and variable within and between species (Schatral 1996). While the removal of the seed coat in several *Hibbertia* species has been reported to improve germination rates, this appears to not to be a physical dormancy but a physiological effect (Allan 2004). Morphophysiological dormancy was also inferred in a number of species with smoke/gibberellic acid (GA) treatments increasing germination response under laboratory conditions (Kullmann 1982). In a preliminary trial at the Australian PlantBank, pre-treating seeds with a combination of smoke, GA and alternating temperature resulted in 48% germination, in comparison to a control treatment result of 1% germination (G. Errington, unpublished data).

Soil environment and translocation sites

With seed collections secured and cutting propagation techniques established, planning and selection of translocation sites for Bankstown Hibbertia commenced. Working closely with Bankstown and Liverpool Councils (who are part of the recovery team) a number of nearby council-managed bushland reserves were identified as potential recipient sites to establish Bankstown Hibbertia. A soil investigation study was undertaken by OEH scientific staff to understand the soil characteristics of the source site, and these potential host sites (Figure 3). Suitability was assessed, based on the compatibility of soil features as well as tenure/management, extant vegetation type, level of disturbance, weed presence, public accessibility and aspect. Following these investigations three priority host sites were selected within a few kilometres range of the source site, which have similar rainfall and temperature and soil profiles. All sites are zoned as conservation areas and managed long term as natural areas by Bankstown and Liverpool Councils.

Genetics and selection of propagation material

Notwithstanding the small population size, and highly restricted distribution of the Bankstown Hibbertia, it is essential that propagation of explants incorporates the maximum genetic diversity present in the wild population. To meet this objective, and guide the propagation sampling strategy, a genetic study was tasked to assess the genetic health, population structure and genetic diversity of the wild population. All sampled plants were metal tagged and georeferenced to allow

Figure 2. Seed collecting of Bankstown Hibbertia at managed grassland site at Bankstown Airport. The small brown seeds (inset) ripen sequentially and require meticulous hand harvesting and repeated visits. Photo: Peter Cuneo

for precise collection of seed and cutting material from the four observed sub-populations at the airport site. Preliminary results from this work indicate a moderate level of inbreeding, and that targeted cutting propagation of identified genotypes (to minimise the levels of kinship with other individuals) should be prioritised. A much smaller proportion of translocation material will also be sourced from seeds collected across the four sub-populations, with sampling guided by the reported levels of inbreeding in each sub-population. Tubestock planting into the selected host sites is scheduled to commence in autumn 2019.

Figure 3. Detailed soil profile testing at potential translocation host site. Photo: Casey Murphy

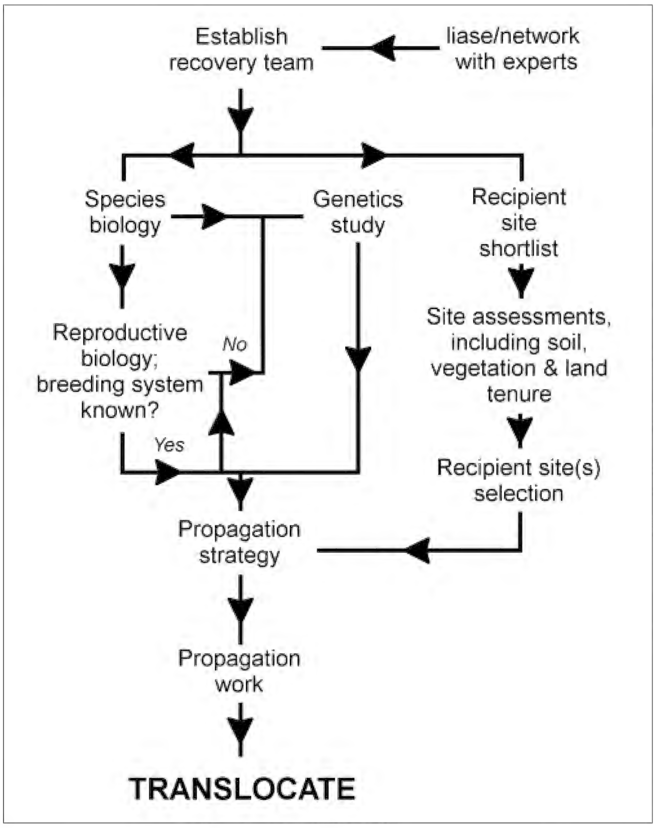

Figure 4. Process diagram of translocation planning for Bankstown Hibbertia.

Conclusion – the importance of pre-translocation planning

Much of the existing plant translocation literature focuses on post-translocation outcomes and targets. However, we strongly advise that practitioners and managers give as much attention (if not more) to the pre-translocation planning phase. As it may take years or decades for a translocated population to become self-sustaining, inadequate planning may compromise long-term success. Indeed, the core target of OEH's 'Saving our Species' program is to ensure a species persists in the wild for the next 100 years. Given that our biological knowledge of Bankstown Hibbertia is incomplete, we have constructed a pre-translocation framework that largely addresses these uncertainties (Figure 4). Surveying potential recipient sites for a suitable soil environment, and vegetation community is key to helping explants adapt and survive in their new environment. Avoiding potential genetic risks such as inbreeding are also critical for long-term translocation success of plants with small and isolated remnant populations. From this, a propagation protocol can be developed that incorporates genotypes to maximise the adaptive capacity and resilience of the translocated population.

Acknowledgements

NSW Office of Environment & Heritage (Ecosystems & Threatened Species) for Saving our Species' project funding, Bankstown Airport Limited, RBG Evolutionary Ecology section for genetic study, Canterbury-Bankstown Council, Liverpool City Council and NSW Local Land Services.

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ANPC workshop report

Banksia Lovers Unite

MARTIN DRIVER[1*], ADAM MILLER[2] AND BONNIE HUMPHREYS[3,4]

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More than sixty Victorian Banksia lovers came together at the Harcourt ANA Hall in central Victoria on 19 March 2018 to hear the latest update on genetics research on *Banksia marginata* and to get a better understanding of what this means and what information it gives about the conservation status of this much-loved species. But most importantly of all, what can be done to restore them to the landscape.

The hall was packed to capacity to hear Adam Miller from Deakin University outline his earlier genetics research relating to the Banksia of the Victorian Volcanic Plains (VVP) as well as the most recent related work on the same species in North Central Victoria. The very successful night was co-ordinated by Bonnie Humphreys from Harcourt Valley Landcare and Connecting Country and highlighted the widespread fascination with the species and concern for its apparent decline and interest in restoration.

Adam's presentation reinforced the general concern that while the species is still widely scattered, it is only the fragmented remnants of a much more connected landscape that is left. As with the volcanic plains results, his current research for north central Victoria indicates that all the sites tested showed that remnants are generally isolated and at high risk of inbreeding and further decline.

His research and the genetic principles that underlie it provide some key recommendations for the future of the species. Adam outlined the need for the regional groups involved in Banksia restoration to focus on bolstering populations sizes and connectivity across the landscape to reduce inbreeding threats. Adam also highlighted the value of capturing seed from the widely scattered current population and bringing them together in multiple seed production areas. This approach will help broaden the genetic basis of seed for combating environmental change, assist in overcoming current seed shortages, and reduce pressure of seed supply from dwindling remnants. This will now be the big challenge for the groups to develop the plan and look for funding to put it into action.

This project was supported by the National Landcare Program, Kara Kara Network, North Central Catchment Management Authority (CMA), the Wetttenhall Environment Trust, Connecting Country and the efforts of many volunteers. Bonnie's co-ordinating efforts are also part of a much wider program of Bringing Back the Banksia's in north east Victoria, southern NSW, northern NSW and South Australia co-ordinated by the ANPC and funded by the Wettenhall Environment Trust to cover the entire genetic range of *Banksia marginata*. The research analysis work is being undertaken co-operatively by both Adam Miller and Maurizio Rossetto from the Royal Botanic Gardens, Sydney Restore and Renew program.

For those wanting a more detailed insight into this research or a copy of the VVP report you may contact Adam Miller at a.miller@deakin.edu.au. Read more at https://connectingcountry.org.au/saving-the-silver-banksia-presentation/

Adam Miller presents the results of his latest genetic research on *Banksia marginata* to a full house at Harcourt, Victoria. Photo: Martin Driver

Member profile

Manfred Jusaitis

Botanic Gardens and State Herbarium, Adelaide, and School of Biological Sciences, University of Adelaide.
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What is your current role?

I am currently an Honorary Research Associate with the Botanic Gardens and State Herbarium in Adelaide, having retired after working there for 25 years in the field of plant conservation biology.

How did you end up working in plant conservation?

I've had an interest in plants since an early age, possibly sparked by my parents' interest in gardening. I remember being fascinated while watching my dad budding and grafting fruit trees in the back yard, and within a few weeks seeing new growth emerge from dormant scions. My parents must have noticed this interest, since they gave me a small section of their garden to call my own, to plant and cultivate whatever I desired. Before long, I was growing an assortment of vegetables and fruit trees from seed and experimenting with budding and cultivation techniques. I never really considered a career in plant science until my first year at university. I had enrolled in a science degree to pursue my favorite subject, physics. One of my first-year subjects was biology, which included a series of lectures by plant physiologist Dr Nick Marinos. His inspirational lectures birthed in me a passion for the subject, and I decided to change my focus from physics to the plant sciences, eventually completing a PhD in Plant Physiology at the Waite Campus of the University of Adelaide.

I worked initially with an agricultural chemicals company, field-testing their plant-protection products in southern Australia, and then held a teaching/research position in plant physiology with the University of Adelaide, before accepting a position with the Botanic Gardens of Adelaide as Plant Scientist in charge of Black Hill Flora Centre.

Members of the *Friends of the Great Victoria Desert* standing in front of a newly discovered population of Wyola mallee, mapped and delineated with the use of a drone. (L to R) Geoff Rishworth, Anne and Manfred Jusaitis, and Harald Ehmann. Photo: Mavik Pro Drone, Manfred Jusaitis, 2017

This position initially involved research into the commercialisation of Australian plants for horticulture and floriculture, as well as studies on the conservation biology of selected threatened plants of our State. However, from 1998, with the shift of our laboratories into the city, our research became totally focused on the conservation biology of our most endangered flora. Our studies covered all aspects of a species ecology and biology, and for many species included translocation trials to gain an understanding of how populations could best be reintroduced, reinforced or enhanced in the wild using this technique.

What projects are you working on at the moment?

When I retired from the Botanic Gardens, I found that I still had a fair bit of interesting data sitting in filing cabinets and on my computer, that remained unpublished. So I have been using my time as an "Honorary" to try to tidy up some of those loose ends by publishing them before the data is lost. Also, recently an opportunity arose via the Threatened Species Recovery Hub of the National Environmental Science Program, to consolidate details of all the plant translocations our Gardens have been involved in over the years, for inclusion in a national translocation review. I am also assisting with the current revision of the ANPC's Translocation Guidelines. These publications should provide very valuable resources for future plant conservationists.

Four years ago, I joined the *Friends of the Great Victoria Desert*, who assist the SA Department for Environment and Water with monitoring and surveying flora and fauna populations in the remote Maralinga Tjarutja lands. Projects we have been involved with include growth and recruitment studies on the vulnerable Wyola mallee (*Eucalyptus wyolensis*) and the majestic marble gum (*E. gongylocarpa*), post-fire recruitment studies, identifying and recording weed infestations, monitoring vegetation photo-points, and assessing the extent of camel grazing damage to quandong (*Santalum acuminatum*) trees. Recently, we have been examining the use of drones to survey and monitor populations of *E. wyolensis* and *E. gongylocarpa* with excellent success. The known range of *E. wyolensis* has been extended significantly as a result of these surveys. Visiting these remote regions also provides unique opportunities to collect plant herbarium specimens from sparsely-surveyed and under-collected areas.

I am also interested in conserving the vegetation of the southern Fleurieu Peninsula, and to that end, 28 years ago I purchased a block of land with a remnant population of messmate stringybark open forest in pristine condition. The land is listed as a conservation block, so can't be cleared or grazed, but a portion of it adjacent to the road is available for planting and I have successfully cultivated some of our endangered species in this area. We have also recently joined the *Friends of Private Bushland*, a group of people who own, or want to help maintain, areas of native bushland on private land, as a means of networking with like-minded individuals.

What is your favorite plant and why?

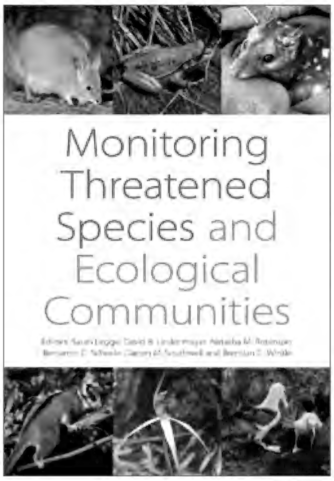
I have found that I fall in love with pretty well all the plants that I spend time studying, but perhaps my real favourites are those that have aromatic leaves. The sense of smell has the powerful ability to transport a person back to a time and a place, while bringing back emotive memories with a rush of nostalgia. So even today, the fragrant, crushed leaves of *Phebalium glandulosum, Dodonaea subglandulifera, Prostanthera eurybioides,* or *Olearia microdisca* will take me back to moments and scenes in the field many years ago, while I was perhaps setting up a flowering experiment, counting or measuring seedlings, or maybe bagging shoots to collect seed. Plant smells can be so evocative!

I also particularly love Tillandsias (air plants), of which I have a collection of over 100 species. I'm fascinated by their diversity, their ability to grow without soil, the challenges involved in their husbandry, their unique beauty and outstanding potential for use as decorative elements.

Book review

Monitoring Threatened Species and Ecological Communities

Editors: Sarah Legge, David Lindenmayer, Natasha Robinson, Benjamin Scheele, Darren Southwell, Brendan Wintle
Paperback | January 2018 | $ 69.95. ISBN: 9781486307715 | 480 pages | 245 x 170 mm. Publisher: CSIRO Publishing.



There is a growing awareness of resources wasted on inefficient and ineffective monitoring. While a book on monitoring methodologies may sound dry, getting monitoring right is the key to knowing whether things are going well, or otherwise. Monitoring is used in almost every workplace you could imagine, but when working with threatened species and communities, monitoring can be the difference between survival and extinction. Monitoring can allow early detection of problems, in time to intervene.

Threatened species have been increasingly in the spotlight in Australia, with the appointment of a Federal Threatened Species Commissioner, ongoing media coverage of large-scale land clearing, and some high-profile species extinctions (e.g. Christmas Island pipistrelle).

This book captures the expertise of about 30 scientists and land managers, who participated in a workshop in 2016 to discuss ways of improving monitoring for threatened biodiversity. The workshop was hosted by the National Environmental Science Programme's Threatened Species Recovery Hub. The book begins by providing overviews of monitoring by species groups: mammals, birds, frogs, reptiles, fish and ecological communities. The chapter on ecological communities (by David Keith *et al.*) is a highlight, not least because of clear descriptions of surveillance vs diagnostic monitoring. Unfortunately there isn't a chapter providing an overview of plant monitoring (of course we'd say that, as this review is in APC), but the authors do note that such work would be useful. The book includes a variety of case studies, from Malleefowl to Dugongs, and there is a case study on plants, emphasising the value of volunteers in monitoring South Australian threatened plants (by Doug Bickerton). The value in these case studies are not in their focal species, but in the common (and uncommon) approaches, and the lessons learnt. This book gives you a framework to think clearly about monitoring.

This book will be of interest to anyone working on monitoring threatened species, or biodiversity in general. The style of the book is very accessible and will be attractive to a spectrum of readers including scientists, field ecologists, consultants, policy makers and land managers. Because of the variety of perspectives in the book, from organisational (e.g. Australian Wildlife Conservancy, NSW Saving our Species program) to on ground, there really is something here for everyone.

Heidi Zimmer

News

Myrtle Rust Draft Action Plan – public comment closes 31st August

Since its arrival in 2010, the Myrtle Rust pathogen *Austropuccinia psidii* has established along Australia's east coast, in the Northern Territory, and marginally in Victoria and Tasmania. It arrived in New Zealand in 2017 and is now established on both North and South Islands. 358 Australian native species are known hosts. About 45 are known or suspected to be severely affected or at risk in the wild.

Two documents have just been released on the Australian situation:

- *'Myrtle Rust reviewed: the impacts of the invasive pathogen* Austropuccinia psidii *on the Australian environment'*
- *'Myrtle Rust in Australia – a draft Action Plan'.*

The draft Action Plan is open for public comment until 31 August 2018. The intent of the *draft Action Plan* is to provide a framework for a nationally coordinated and adequately resourced environmental response to Myrtle Rust. Such a response has been lacking to date in Australia.

The intent of the *Review of impacts* is to provide the evidentiary basis for the proposed actions, and to show their urgency. This is the first attempt at a comprehensive overview of the environmental effects of the pathogen, and is outside the silos of the technical journals where much of the previous literature sits.

Uptake of the draft Action Plan, and resourcing of its recommended actions, are not a given, and will depend in part on public and professional feedback during the comment period. Please alert your home organisations and networks to these documents and the opportunity to comment on the draft Action Plan, and encourage them to do so by deadline.

The Review and draft Action Plan were co-funded by the National Environmental Science Program (NESP) of the Commonwealth Department of Environment, and the Plant Biosecurity Cooperative Research Centre (PBCRC).

Both documents are available in PDF format at **www.apbsf.org.au**.

Progress report on the 3rd edition of the '*Guidelines for the Translocation of Threatened Plants in Australia*' – June 2018

The project to update the ANPC's Translocation Guidelines is progressing well. A draft of all of the chapters is complete and the editing is continuing. Many authors have kindly provided photos of various aspects of translocation, which will illustrate techniques as well as making the new edition visually attractive. Twenty-two case studies from across Australia have been submitted so far, and have been or will be published in Australasian Plant Conservation with excerpts being incorporated into the guidelines. These case studies showcase best practice translocation of a variety of life forms including trees, shrubs and orchids, and across a number of habitats.

In April 2018, Dr David Coates organised a Threatened Species Recovery Hub workshop on *Scoping the Benefits of Gene Pool Mixing for Threatened Plant Translocations*. Over 20 geneticists, ecologists, and translocation experts met at the Royal Botanic Gardens Victoria to discuss the topic. Attendees identified that in some cases, gene pool mixing has the potential to rescue plant species from extinction, whereas in other cases, the consequences may be detrimental to the species. A paper is being prepared resulting from the discussion at the workshop. Useful feedback on two chapters of the Guidelines was also received at the workshop, and is being incorporated.

The ANPC's Project Manager, Lucy Commander, had the opportunity to publicise the 3rd edition of the Guidelines at a recent Science Forum held by the Western Australian Department of Biodiversity, Conservation and Attractions. Lucy also presented at the recent Threatened Species Recovery Hub Roadshow in Brisbane on 31 May.

Don't forget, there will be a 1-day Translocation Workshop as part of the 12th Australasian Plant Conservation Conference in Canberra in November 2018. You will be able to hear all about the new Guidelines, and presentations will be given by several of its authors. There will also be opportunities to ask questions and network.

Thank you to all of the Guidelines' authors and the case study authors for contributing to this worthwhile project.

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Project Manager, Guidelines for the Translocation of Threatened Plants in Australia
http://www.anpc.asn.au/translocation_guidelines_review

Participants at the Threatened Species Recovery Hub's gene pool mixing workshop in Melbourne in April 2018. Photo: Rachel Morgain, TSR Hub

Cuttings: Plant news from around Australia

The Orchid and the Wasp: the life and work of naturalist Edith Coleman

Edith Coleman was a brilliant amateur naturalist and science writer of the early 20th Century, who made stunning discoveries about the behaviour of orchids and wasps. Rising from obscurity at the age of 48, Edith became a prolific contributor to journals, newspapers and magazines; and was famous for translating the complexities of flora and fauna into vivid plain English. At the height of her career, Edith's reputation was so great that she was said to 'need no introduction'; and in 1942, she became the first woman to be awarded the Australian Natural History Medallion.
http://www.abc.net.au/radio/programs/conversations/danielle-clode/9602044

Flora fatale: The carnivorous plant that scared Charles Darwin

Who do you barrack for: the hunter or the prey? The leopard or the gazelle? The frog or the snake? The fly or the flytrap? Enter the glittering and sensual world of plants with a thirst for blood.
http://www.abc.net.au/news/science/2018-04-01/carnivorous-plants-drosera-insect-killers/9596170
http://www.abc.net.au/radionational/programs/offtrack/flora-fatale/9591130

Climate change makes mountain tops bloom, for now

Europe's mountain summits are flush with new plant species, a greening that has increased in lock-step with the acceleration of global warming since the mid-20th century, researchers said Wednesday. Looking at more than 300 summits scattered across the continent, they found that five times as many plant types migrated to higher ground over the last decade than did 50 years ago, from 1957 to 1966. High mountain areas have warmed nearly twice as much as the planet as a whole, which has seen an increase of one degree Celsius (1.8 degrees Fahrenheit) since the mid-19th century. "Across all summits, the increase in plant species richness has accelerated," a team of 53 scientists led by Sonja Wipf from the Institute for Snow and Avalanche Research in Davos, Switzerland reported in the journal Nature. "This acceleration has been particularly pronounced during the past 20-30 years."
https://au.news.yahoo.com/climate-change-makes-mountain-tops-bloom-for-now-39730533.html

Global warming could wipe out almost 70 per cent of Amazon species

At warming of 4.5C, the Amazon could risk the local extinction of 69 per cent of its plant species. Global warming could place 25 to 50 per cent of species in the Amazon, Madagascar and other biodiverse areas at risk of localised extinction within decades.
https://www.sbs.com.au/news/global-warming-could-wipe-out-almost-70-per-cent-of-amazon-species

The Queen unveils climate change initiative in interview with Sir David Attenborough

In an interview with iconic environmentalist Sir David Attenborough, The Queen has detailed a new initiative to protect the Commonwealth's climate. The Queen's Commonwealth Canopy (QCC) is an initiative to build a network of forest conservation projects around the world. QCC involves 53 Commonwealth countries, raising awareness of indigenous forests, facilitates knowledge exchange and allowing participating countries to share best practice for forest conservation across the Commonwealth.
http://www.news.com.au/entertainment/celebrity-life/royals/the-queen-and-sir-david-attenborough-join-forces-to-fight-climate-change/news-story/53691778324547aa3043d717b6c1c510
https://mysunshinecoast.com.au/news/news-display/kgari-and-bulburin-national-park-added-to-the-queens-commonwealth-canopy,54198

WA shuts its eyes as precious ecosystems head towards 'profound crash'

Western Australia's wildlife and ecosystems are heading for a profound crash, and there's no comprehensive government blueprint in place to steer conservation and prevent major losses. A World Wildlife Fund report published on March 14 considered the potential effects of climate change on biodiversity in 35 global "priority places", including Australia's south-west. "Even if the global mean temperature rise is constrained to 2C, south-west Australia is projected to become unsuitable for 30-60 per cent of species across all groups [by the 2080s]," it said. WA is the only Australian state that doesn't have a state-wide plan to conserve biodiversity.
https://www.smh.com.au/national/western-australia/wa-shuts-its-eyes-as-precious-ecosystems-head-towards-profound-crash-20180410-p4z8uj.html?

NSW Government's land-clearing law quashed in court, deemed invalid

In a breakthrough victory, the Land and Environment court has ruled the NSW Government's land-clearing laws were made unlawfully, and were therefore invalid. The Nature Conservation Council fought the legislation made by the Berejiklian Government, which had permitted private landholders to carry out large-scale clearing of native vegetation without prior approval or environmental assessment.
http://www.abc.net.au/news/2018-03-09/nsw-government-land-clearing-law-quashed-in-court-invalid/9531640

Norfolk Island Flora Week

This trip to Norfolk Island will explore the plants and forests of the island with the foremost authority on the flora of this remote island. Daily walks in the forest will be complemented with lectures on the flora, with particular reference to its origins and conservation. With Dr Kevin Mills, Botanist and Vegetation Ecologist, local Norfolk Island flora expert Margaret Christian, and Derek Ball, CEO Wildmob Wilderness Conservation & Chair of Island Arks Australia. The rainforest on Norfolk Island is unique; neither the endemic species nor the combination of plant and animal species found on Norfolk occur anywhere else in the world. The isolation of the island in the middle of a large ocean, the subtropical latitude and the geographic location between Australia, New Zealand and the tropical islands to the north, were paramount in determining the character of the rainforest that was to evolve on Norfolk Island and that we see today. Like many islands, endemism is high, endemic plants accounting for about 24 percent of the total indigenous flora.
https://www.norfolkislandtravelcentre.com/events/norfolk-island-flora-week

Coastal Swamp Oak Forest on the list of threatened ecological communities

Assistant Minister Price has approved the inclusion of the Coastal Swamp Oak Forest of New South Wales and South East Queensland in the endangered category on the list of threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999*.
http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=142

The botanist, the chemist, and the painkilling lettuce

In a special high-security glasshouse in Melbourne's east, racks upon racks of lettuce, canola, green beans and tobacco are growing. Inside each plant's leaves and seeds, a secret has been carefully tucked away. These plants have been coaxed, using careful genetic manipulation, into growing painkillers and anti-cancer drugs. The team behind them hope these "biofactories" could be cultivated in developing nations or remote communities, providing a cheap and plentiful source of powerful edible drugs.
https://www.smh.com.au/national/the-botanist-the-chemist-and-the-painkilling-lettuce-20180316-p4z4nf.html

The fast-growing weed that could destroy our ecosystems

Residents have been urged to search for this fast-spreading invasive tree after it was discovered on a Sunshine Coast property. The Mexican bean tree, a priority invasive plant for the Sunshine Coast Council local government area, has been discovered on a property in Glenmount Road, Buderim in the Mooloolah River catchment. The Mexican bean tree is listed as a restricted invasive plant under the Biosecurity Act 2014. Council Vector and Pest Plant Education and Control team leader Mark Call said the fast-growing trees were quick to colonise and had the potential to cause serious and irreversible damage to native ecosystems.
https://www.sunshinecoastdaily.com.au/news/the-fast-growing-weed-that-could-destroy-our-ecosy/3365085/

No species too ugly to save

No species is too small, too ugly or too remote to be beyond saving, according to a national compilation and review of almost 50 successful examples of threatened species recovery in Australia. The review was led by the Threatened Species Recovery Hub of the Australian Government's National Environmental Science Programme, and has just been published by CSIRO Publishing, aptly titled 'Recovering Australian Threatened Species: A Book of Hope.'
http://www.nespthreatenedspecies.edu.au/news/media-release-no-species-too-ugly-to-save

1000 species of Australian Seeds

Over 1000 species of Australian native seeds from the collections of the National Seed Bank at the Australian National Botanic Gardens are now available as digital images. The Centre for Australian National Biodiversity Research (CANBR) has digitised the images, including seed measurements, to help explain the functions of these important species. The project was supported through funding from the Australian Biological Resources Study's Bush Blitz Program. You can explore the seed images on the Australian Plant Image Index.
https://www.anbg.gov.au/photo/search-all-plant-short.html

Wetlands Australia: National Wetlands Update February 2018

This edition highlights Wetlands for a sustainable urban future, the theme for World Wetlands Day 2018. Urban wetlands provide refuges for wildlife as well as welcome retreats from the hustle and bustle of city life for workers and families. Some urban wetlands, including constructed wetlands, can remove sediment and pollutants from urban runoff – providing clean water that can also be used for irrigating sporting fields, watering gardens and preventing pollutants entering rivers and estuaries. You will also find articles about internationally-significant Ramsar wetlands, habitat restoration in coastal and inland settings, community engagement and innovative approaches to wetland management.
http://www.environment.gov.au/water/wetlands/publications/wetlands-australia/national-wetlands-update-february-2018

Don't be a Jeff: New social media campaign raises awareness of biosecurity

People in the agriculture sector know and understand the importance of biosecurity – we live and breathe it every day. However, managing biosecurity risk is the responsibility of all Australians, and we need to tell that story. With this in mind, the Department of Agriculture and Water Resources has launched a new social media campaign to encourage awareness of biosecurity.
The webpage for the Biosecurity Matters campaign aims to engage the public on what biosecurity is, why it matters and what their role is in the system. It's also designed to be a resource that can help you to share the biosecurity story with friends, families, stakeholders and clients, to ensure that all Australians understand the importance of our country's biosecurity.
https://ausveg.com.au/articles/dont-jeff-new-social-media-campaign-raises-awareness-biosecurity/

Native Seed Distribution Technique Survey

Monte Masarei, PhD Candidate at UWA, is looking for survey respondents who have practical experience in the native seed industry to help build a picture of how seeds are being used in such projects. Information from this survey will be used to identify where bottlenecks to successful restoration using native seeds lie. If you have experience planting tube stock or using some form of direct seeding method for revegetation or restoration, you can take part in this 15-minute survey.
https://uwa.qualtrics.com/SE/?SID=SV_8H1WHkPZYuNWGwZ&Q_JFE=0

NSW and ACT 2018 Threatened Species Children's Art Competition

The 2018 competition will be open for entries between June 4 and August 2, 2018. The 2018 competition will be open to children 5-12 years old in NSW and the ACT. Fifty finalists' works will hang in a two week exhibition in September, with winners announced on September 7, Threatened Species Day. The Threatened Species Children's art competition helps children unleash their artistic creativity while learning about the extinction crisis facing our native plants and animals.
http://www.threatenedspeciesartcomp.net.au/

Time is running out to capture Australia's biodiversity, but we have a plan

Naturalist, broadcaster and Fellow of the Australian Academy of Science, Sir David Attenborough, is endorsing calls for greater support for the scientists who study and name Australia's plants and animals and other organisms, declaring that Australia's current capacity is not adequate for the magnitude of the task. Sir David says that at the very time that many species are under greatest threat, funding and other resources allocated to discovering and documenting species are declining. "This has serious consequences for the future of life on Earth," he says in the foreword to the Australian Academy of Science and the Royal Society Te Apārangi's 10-year plan for taxonomy and biosystematics, launched at Parliament House, Canberra 27 April 2018.
https://www.science.org.au/news-and-events/news-and-media-releases/time-running-out-capture-australias-biodiversity-we-have-plan

Plants ‘talk to’ each other through their roots

Plants use their roots to “listen in” on their neighbours, according to research that adds to evidence that plants have their own unique forms of communication. The study found that plants in a crowded environment secrete chemicals into the soil that prompt their neighbours to grow more aggressively, presumably to avoid being left in the shade.
https://www.theguardian.com/science/2018/may/02/plants-talk-to-each-other-through-their-roots?CMP=Share_iOSApp_Other

A new garden for Canberra’s National Botanic Gardens – Canberra Times, 6 May 2018

Gardening Australia host Costa Georgiadis officially opened the new conservation and research garden in Canberra’s botanic gardens in Acton. The new garden features a living collection of threatened plant species, and gives visitors a first-hand look at the conservation work botanic gardens are involved in. “The new garden contributes to the conservation of many threatened plants and by having these species here growing and thriving, acts as an insurance policy for the remaining plants surviving in the wild,” said David Taylor from the National Botanic Gardens.
https://www.canberratimes.com.au/national/act/a-new-garden-for-canberra-s-national-botanic-gardens-20180504-p4zdgw.html

Botany at its best: Global conservation gong for Wollongong’s Botanic Garden

There’s gardening, and then there’s botanic gardening. And in the latter world, Wollongong’s Botanic Garden is riding high – it has been recognised by a global garden network for its approach to plant conservation. It has become one of just seven gardens worldwide to receive recognition from the Botanic Gardens Conservation International group (BGCI) as its first recipients of botanic garden accreditation.
https://www.illawarramercury.com.au/story/5391530/botany-at-its-best-global-conservation-gong-for-our-top-garden/

Amendments to the EPBC Act list of threatened species

The Assistant Minister for the Environment, the Hon. Melissa Price MP, has approved the inclusion of 34 plant species (including *Caladenia attenuata*, *Pomaderris delicata* and *Banksia catoglypta*), transfer of 4 plant species, and the removal of 1 species (*Ptilotus fasciculatus*) on the list of threatened species under the Environment Protection and Biodiversity Conservation Act 1999, effective 11 May 2018.
http://www.environment.gov.au/node/45641

Dozens of animals and plants join Australia’s threatened species list

What do tingle pygmy trapdoor spiders from Western Australia, silver-headed antechinus from central Queensland and Duramana fingers orchids from NSW have in common? If you’re waiting for a funny punchline, sorry – the answer is that they’re among the 41 new species of Australian plants and animals that are now officially at risk of extinction. The good news though is that this listing could, potentially, be the first step towards reversing the country’s world leading extinction rate. Those 41 species were among 50 changes to the country’s official threatened species list after its annual update. As well as the additions, both the Wollemi pine – noted as the botanical find of the century – and the western ringtail possum have deteriorated to become “critically endangered.
https://www.smh.com.au/environment/conservation/dozens-of-animals-and-plants-join-australia-s-threatened-species-list-20180512-p4zexo.html

Research round up

COMPILED BY KIRSTIN COWLEY

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Threatened plants from the ACT region all growing at the Australian National Botanic Gardens in Canberra: *Swainsona recta* (Small purple pea) – Lily Berry; *Rutidosis leptorrhynchoides* (Button Wrinkewort) – Jo Lynch; *Calotis glandulosa* (Mauve Burr-daisy) – Lily Berry.